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HEALTH AND PERFORMANCE OF ANTARCTIC WINTER-OVER  
PERSONNEL: A FOLLOW-UP STUDY(U) NAVAL HEALTH RESEARCH  
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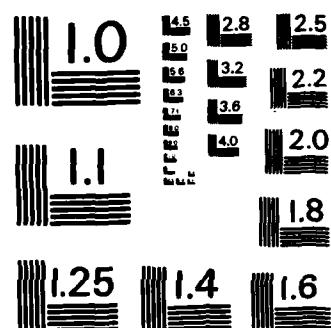
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**L. A. PALINKAS**

**REPORT NO. 85-18**

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HEALTH AND PERFORMANCE OF ANTARCTIC WINTER-OVER PERSONNEL:  
A FOLLOW-UP STUDY

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Report No. 85-18  
supported by the Naval Research and Development Command, Department of the Navy, under Research Work Unit MR000.01.01-6035. The views represented in this paper are those of the author. No endorsement by the Department of the Navy has been given nor should any be inferred.



## SUMMARY

### Problem

Despite extensive previous research on the health and performance of Antarctic winter-over personnel while they are "on the ice," little is known about the long-term effects of the winter-over experience. The prolonged isolation during this period is associated with numerous social and psychological stressors, in addition to physiological changes.

### Objective

The objective of this study was to compare enlisted Navy personnel who have wintered-over in the Antarctic with a control group to determine if they are at risk for illness upon their return or if their subsequent performance in the Navy is significantly affected by the winter-over experience.

### Approach

Cases were defined as enlisted Navy personnel who wintered over between 1963 and 1974. A control group was comprised of individuals who applied for the Operation Deep Freeze Program during the same period and were given a favorable evaluation by a screening team, but who did not winter-over. A fifteen year period from 1965 to 1979 was established for follow-up. Three types of data were examined: demographic characteristics obtained from the Operation Deep Freeze and Navy Enlisted History Files; inpatient medical data, including all first hospitalizations for all diagnoses which occurred after entry into the study; and service history information, including number of promotions, demotions, unauthorized absences, desertions, medical and physical evaluation board hearings, deaths, and type of discharge.

### Results

The winter-over group was significantly older with a higher pay grade and greater number of years served in the Navy at the time of evaluation for the Operation Deep Freeze Program. They were also less educated than controls and included greater proportions of blue collar occupations and hospital corpsmen. The rate of first hospitalizations for the winter-over group was significantly less than the rate for the control group. The winter-over group also had significantly fewer first hospitalizations for neoplasms; endocrine, nutritional, and metabolic diseases; and diseases of the musculoskeletal system. No significant differences were observed on any of the performance indicators.

### Conclusions

The winter-over experience does not appear to place enlisted personnel at significant long-term risk for first hospitalizations subsequent to their return from the Antarctic. The stressors associated with prolonged isolation in a harsh environment appear to be mediated by personality, socioenvironmental, and sociocultural factors.

### Recommendations

Further research is needed to determine why winter-over personnel have significantly fewer first hospitalizations. The association between variations in immunocompetence and decreased risk for neoplasms, endocrine, nutritional, and metabolic disorders also requires further study.

Health and Performance of Antarctic Winter-over Personnel:  
A Follow-up Study

Antarctica has long been regarded as a natural laboratory for studying the stresses on health and human performance associated with isolation in an extreme environment (7, 24, 25). The intense cold, low humidity, high altitude of interior stations, and prolonged isolation during the winter are major stresses (4). As such, it serves as a model for the type of stressors that may be encountered by individuals in other extreme environments such as the proposed space station to be constructed in the 1990s (26).

These stressors become particularly manifest during the long austral winter. The prolonged isolation during this period is associated with numerous social and psychological stressors. Polarization of subgroups of civilian and military personnel and the formation of cliques has been frequently reported. Palmai (21) noted an increase in group conflict over the course of the winter-over period. According to Gunderson (5), group compatibility and accomplishment typically decline in Antarctic groups after prolonged isolation with wide differences among groups in the amount of deterioration. Three main psychological stressors at Antarctic bases were identified by Mullin (17): (1) problems of individual adjustment to the group; (2) relative uniformity of milieu; and (3) absence of many accustomed sources of gratification, both sexual and gastronomic, and a lack of variety of companionship.

The stress resulting from these conditions is often manifested in a common set of symptoms. Many individuals experience mild to moderate psychological disturbances after several months of winter confinement (6). The symptoms listed below have been found to some extent in every group of men wintering in Antarctica (19). They are: (1) insomnia, popularly known as 'big eye'; (2) irritability; (3) headache; (4) nightmares; (5) anxiety; (6) mild depression; (7) boredom; (8) fatigue; (9) decline in personal hygiene; (10) reduced motivation combined with intellectual inertia, impaired memory, impaired concentration, decline in alertness, and a general apathetic state; (11) increased appetite, frequently accompanied by weight gains; (12) digestive ailments; (13) rheumatic aches and pains; and (14) increased sensitivity to physical and social stimuli. These symptoms appear to increase over time during the winter, peaking at mid-winter (5). Cases of psychoses or severe neurosis have been extremely rare at Antarctic stations (7), but the few cases which have occurred were serious in nature (18, 27).

In addition to the psychological changes, physiological changes among winter-over personnel also are apparent. Dyspnea, anorexia, insomnia, and headaches are frequent symptoms at all Antarctic research stations. Arterial hypoxia, hyperventilation, and erythrocytosis are common in the high altitude environment of South Pole Station (4). The physiological changes incident to hypobaric hypoxia has resulted in several cases of acute mountain sickness with insomnia as a major symptom (24). In one study of personnel at South Pole Station, carboxyhemoglobin was present in significant amounts, even in nonsmokers, and may be related to inadequate ventilation of underground living quarters (4). In another study, Muchmore et al (14) reported a significant drop in the number of circulating

leukocytes among five subjects at South Pole Station throughout the winter. Immunoglobulin concentrations also have been found to undergo a significant decline during the Antarctic winter (16), while increases in urinary catecholamine excretion levels have been noted (2).

Although information has been collected over the years on the health and well-being of winter-over personnel while they are "on the ice," we know very little about these individuals once they have returned to "the real world." A study by Oliver (20) found that adjustment problems and "culture shock" to home and new surroundings were common for departed winter-over personnel, and Natani and Shurley (19) point to potential stressors that may accompany the process of readjustment to the larger society. However, few studies have specifically addressed the question of whether prolonged isolation in an extreme environment has any long-term effects on health and performance.

Over the years, scientific research and navy support personnel wishing to go to the Antarctic have been screened by Navy psychiatrists and psychologists in a program known as Operation Deep Freeze. Information has been collected from these individuals prior to, during, and after their stay in the Antarctic in the attempt to improve screening methods so that performance may be predicted and the risk of psychiatric or medical emergencies while on the ice reduced. By comparing the information on enlisted Navy personnel with their medical and service histories, we are able to conduct a follow-up of the health and performance of these individuals upon their return from their Antarctic assignments.

The object of this study was to compare those personnel who have wintered-over in the Antarctic with a group of controls to determine if they are at risk for illness upon their return. We tested the hypothesis that there is no significant difference on health and performance indicators between winter-over personnel and personnel who were screened and judged to be acceptable but who did not winter-over.

#### METHODS

Records of screening evaluations by teams of psychiatrists and clinical psychologists between 1963 and 1973 were compiled into a computerized file at the Naval Health Research Center. The Operation Deep Freeze file contains biographical and service history information, and psychological screening results on 4,557 military and civilian applicants. Information on peer group evaluations and supervisor evaluations also are contained in this file.

For this study, cases were defined as those who wintered over between 1963 and 1974. A control group was comprised of individuals who applied for the Operation Deep Freeze Program during the same period and were given a favorable combined evaluation by a clinical psychologist and psychiatrist but who did not winter over. Subsequent examination of the data indicated that some individuals who were given a negative evaluation eventually did winter-over. Nevertheless, this criterion was adopted so as to establish uniformity between cases and controls.

Only Navy enlisted personnel were selected for follow-up because of the availability of

medical and service history data on these individuals. The Naval Health Research Center maintains an Inpatient Medical Data File which contains records on all hospitalizations, medical and physical evaluation board hearings, and deaths for all active duty enlisted Navy personnel for the period 1965-1981. Data files obtained from the Manpower and Personnel Management Information System (NMPC 15642) contain service history information on all enlisted personnel during this period as well. These two files were searched for all medical and service history information on the Navy enlisted personnel identified from the Operation Deep Freeze File. Follow-up information was obtained on 3,076 individuals on the basis of matching social security or service numbers. Of these individuals, 327 were identified as having wintered over between 1965 and 1973 and not having a negative combined evaluation by the psychiatrist/psychologist screening team. The control group was comprised of 2,396 individuals who were screened during the study period and were considered to be acceptable by the screening team but who nonetheless did not winter over.

A fifteen year period from 1965 to 1979 was established for follow-up. This was based on the period of time for which medical and service history information was available for both groups at the time the study was conducted. The start date for participation in the study was established as 1 January 1965 or the year an individual was evaluated for the Operation Deep Freeze Program if after this date. Withdrawal was defined as the date of last discharge from the Navy or 31 December 1979, whichever came first.

Three types of data were examined in this study. Demographic characteristics were obtained from the Operation Deep Freeze and Navy Enlisted History Files and included age at application to Operation Deep Freeze, race, education, pay grade, occupation, and length of service. Inpatient medical data included all first hospitalizations for all diagnoses which occurred after entry into the study (i.e., subsequent to screening for Operation Deep Freeze). Diagnoses were in accordance with the Eighth Revision, International Classification of Disease Adapted for Use in the United States (ICDA-8). Age at hospitalization, medical and physical evaluation board hearings, and death records also were obtained from the Inpatient Medical Record. Service history information obtained from the Navy Enlisted History File included number of promotions, demotions, unauthorized absences, and desertions, and the last change which includes type of discharge.

Age-adjusted rates for the diagnostic categories were calculated using the direct method of adjustment (11). The standard population was comprised of all study participants. The rates for the winter-over and control groups were compared to obtain estimates of relative risk by taking the ratio of rates for the winter-over group to rates of the control group. Levels of significance of these associations were obtained using 95 percent confidence intervals. One-way analysis of variance, chi-square and t-tests were employed to determine levels of significance for observed differences in the demographic characteristics and service history outcomes of both groups.



## RESULTS

### Demographic Characteristics

A comparison of the demographic characteristics of the winter-over and control groups is contained in Table 1. The winter-over group is significantly older with a higher pay

Table 1  
Characteristics of Winter Over and Control Groups  
Operation Deep Freeze Participants: 1965-1979

	<u>Winter Over</u>		<u>Controls</u>		<u>Significance</u>
Mean Age	27.11		25.98		P<.001
Mean Pay Grade (E1-E9)	5.14		4.86		P<.001
Mean Length of Service (Years)	8.18		6.83		P<.001
<u>Education</u>	N	%	N	%	
8th Grade or Less	19	5.8	105	9.9	
Grades 9 to 11	93	28.8	564	19.1	
High School Graduate	180	55.7	1,340	56.0	
College	31	9.6	371	16.0	P<.004
<u>Race</u>	N	%	N	%	
White	317	96.9	2,293	95.7	
Non-White	10	3.1	103	4.3	N.S.
<u>Occupational Group</u>	N	%	N	%	
Blue Collar	170	52.0	1,208	50.5	
Electronic/Technical	67	20.5	572	23.9	
Administrative/Cooks	55	16.8	359	15.0	
Recruits/Apprentice	1	0.3	103	4.3	
Hospital Corpsmen	34	10.4	148	6.2	
Other/Unknown	0	0	6	0.1	P<.001

grade and greater number of years served in the Navy at the time they were evaluated for the Operation Deep Freeze program. They were also less educated than the controls. Blue Collar occupations and hospital corpsmen were represented in greater numbers in the winter-over group, while the control group had significantly more apprentices and unrated personnel. No significant racial group difference was observed.

### First Hospitalizations

The incidence of first hospitalizations for all diagnostic categories is represented in Table 2. The rate of total first hospitalizations for the winter-over group was significantly less than the rate for the control group. The winter-over group also had significantly fewer first hospitalizations for neoplasms; endocrine, nutritional and metabolic diseases; and diseases of the musculoskeletal system, than the control group. Differences observed in the remaining diagnostic categories failed to reach statistical significance.

### Performance indicators

Table 3 provides a summary of selected service history and performance indicators of the two groups. No significant differences were observed on any of the performance indicators. The winter-over group has slightly more promotions and unexcused absences and slightly fewer demotions and physical evaluation board hearings than the control group but these differences failed to reach statistical significance.

Table 2  
Age Adjusted Incidence Rates for Winter-Over and Control Groups  
Operation Deep Freeze Participants: 1965-1979  
(per 10,000 person years)

Diagnostic Category	Winter-Over		Controls		Relative Risk	95% CI	
	N	Rate	N	Rate			
Infective and Parasitic Diseases	9	45.01	48	37.39	1.20	2.05	0.35
Neoplasms	2	9.53	45	35.38	0.27	0.65	-0.11
Endocrine, Nutritional and Metabolic Diseases	3	14.07	44	34.55	0.41	0.89	-0.07
Diseases of Blood and Blood-Forming Organs	3	14.13	8	6.29	2.25	5.24	-0.74
Mental Disorders	10	47.02	94	73.84	0.64	1.06	0.22
Diseases of the Nervous System and Sense Organs	7	32.89	59	46.17	0.71	1.27	0.15
Diseases of the Circulatory System	17	81.97	114	89.54	0.92	1.39	0.45
Diseases of the Respiratory System	14	65.26	75	58.80	1.11	1.74	0.48
Diseases of the Digestive System	24	114.91	155	121.71	0.94	1.34	0.54
Diseases of the Genitourinary System	7	33.23	60	46.96	0.71	1.27	0.15
Diseases of Skin and Subcutaneous Tissue	7	33.06	46	36.04	0.92	1.65	0.19
Diseases of the Musculo-skeletal System	10	46.63	106	83.22	0.56	0.92	0.20
Congenital Anomalies	4	18.83	15	11.79	1.60	3.36	-0.16
Symptoms and Ill-Defined Conditions	7	33.02	66	51.73	0.66	1.17	0.15
Accidents, Poisonings, and Violence	25	117.99	207	161.19	0.73	1.07	0.43
Supplementary Classifications	7	32.74	50	39.17	0.84	1.50	0.18
TOTAL First Hospitalizations Person Years at Risk	156 2001	740.32	1190 12828	932.25	0.79	0.92	0.66

#### DISCUSSION

A number of limitations to the findings of this study are apparent. Because of the lack of follow-up data, civilian scientists and technicians and Navy officers were not included in the study. Previous research has noted that these individuals come from different sociocultural backgrounds and display different patterns on performance and psychological adjustment while wintering over in the Antarctic (9, 19). Thus, only a partial representation of the wintering over experience and its effect on health and performance is provided in this study. Finally, as noted above, only personnel who were given a combined psychologist-psychiatrist evaluation as being fit for winter-over duty were included; not all personnel who wintered over were included in the study. Eleven individuals who were given a negative evaluation in the first year of the screening program nonetheless did subsequently winter-over because of a shortage of candidates with the necessary occupational skills. Nevertheless, a significantly higher percentage of applicants who did not

Table 3  
Service History of Winter Over and Control Groups  
Operation Deep Freeze Participants: 1965-1979

	<u>Winter Over</u>		<u>Controls</u>		<u>Significance</u>
	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>	
Promotions	203	62.1	1,394	58.2	N.S.
Demotions	5	1.5	44	1.8	N.S.
Unexcused Absences	8	2.4	28	1.2	N.S.
Desertions	2	0.6	11	0.5	N.S.
<u>Last Change Grouped</u>					
Reenlisted	5	1.5	55	2.3	
Promoted	3	0.9	19	0.8	
Demoted	0	0	1	0.0	
Extension	4	1.2	81	3.4	
Released to Inactive Duty	225	68.8	1,540	64.3	
Honorable Discharge	41	12.5	371	15.5	
General Discharge	2	0.6	14	0.6	
Bad Conduct Discharge	2	0.6	5	0.2	
Other Discharge	9	2.8	76	3.2	
Died	3	0.9	25	1.0	
Duty Station Change	29	8.9	186	7.8	
Hospitalization	1	0.3	5	0.2	
Physical Evaluation Board	3	0.9	16	0.7	N.S.
<u>Medical Disposition</u>					
Medical Boards	12	3.7	83	3.5	N.S.
Physical Evaluation Boards	6	1.8	72	3.0	N.S.
Died in Service	3	0.9	25	1.0	N.S.

winter over were given negative evaluations. In order to reduce the potential bias created by the negative evaluation, these individuals were eliminated from the study.

Despite these limitations, the results do indicate that the winter-over experience does not appear to place enlisted personnel at significant risk for first hospitalizations subsequent to their return from the Antarctic. In fact, the winter-over group had significantly fewer total first hospitalizations than the control group. When individual diagnostic categories were examined, the winter-over group had significantly fewer first hospitalizations for neoplasms; endocrine, nutritional and metabolic diseases; and diseases of the musculoskeletal system. No significant differences were observed on any of the performance indicators.

While the results indicate that the stresses associated with wintering over in the Antarctic do not significantly affect the subsequent health and performance of enlisted personnel, the differences which were observed are difficult to explain. Although not significantly different from that of the control group, the lowered risk for mental disorders and accidental injury among the winter-over group is evidence of the effectiveness of the screening program in weeding out those at risk for hospitalization both on and off the ice. "There are four primary areas in the determination of psychiatric suitability for the Antarctic program: motivation, history of past personal effectiveness, present ego strength and adequacy of defense mechanisms, and adequacy of interpersonal relationships. Thus individuals who showed no obvious defects or weaknesses in these four areas were considered sufficiently stable to adjust in the Antarctic-- or for that matter for almost any program of this nature" (18). However, psychiatric suitability alone does not discriminate between the two groups in this study because both the winter-over and control groups are comprised of individuals who were evaluated as suitable for winter-over duty.

to show any meaningful risk in respiratory illness among winter-over personnel. Moreover, a reduction in immunocompetence should lead to an increased risk for neoplasms and endocrine disorders, not a decreased risk as found in this study (3, 12). The association between variations in immunocompetence and decreased risk of hospitalization for neoplasms, endocrine, nutritional, and metabolic disorders, therefore, requires further study. The decreased risk for diseases of the musculoskeletal system also requires further study.

The results of this study, nevertheless, appear to have great relevance for research on the relationship between stress and illness. The environmental factors of extreme cold, high altitude, and isolation appear to have no long-term adverse effects after returning to the outside world. It would appear that the effects of these stressors are mediated by personality, socioenvironmental, and sociocultural factors. For instance, certain personality traits have been found to be more useful in the process of adjusting to the Antarctic environment than others. Natani and Shurley (19) observe that social isolates who exhibit behaviors viewed by outsiders as immature tend to adapt better to prolonged confinement than men with strong needs for gregarious activity. Palmai (7) noted that there were significantly fewer sick calls made by social isolates than by the more group-centered personnel. Improvements in the station facilities may also contribute to improved adjustment and decreased stress. According to Mullin (8), the absence of much hardship and danger and the relative luxury of living conditions were sources of considerable disappointment and disillusionment for many of the younger and more romantically inclined members of a winter-over party. The sociocultural environment may also help to promote successful psychological adjustment which in turn decreases the risk of long-term effects on health and performance. Natani and Shurley (19) note that all "successful" wintering parties at small stations appear to have attained some degree of homogeneity based on social comparison processes and sociocultural reorganization.

These three sets of potential intervening factors in the stress-illness relationship require further study. Subsequent research will examine the scores on the various psychological tests administered to both groups to determine if personality factors as measured by screening scales predict for hospitalization independent of wintering over. An examination also will be made of possible changes in hospitalization rates over time to see if improvements in station environments have reduced the risk for illness.

#### ACKNOWLEDGEMENTS

The author wishes to thank Patricia Coben for her invaluable assistance in performing the data analysis for this study.

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Other factors, such as the need for a certain occupational skill at a particular research station and the previous experience of the applicant are used in the final determination as to who does winter-over. Similarly, because both groups are comprised of volunteers, self-selection of highly motivated winter-over personnel does not explain the observed differences.

Age, education, and occupation are all known to affect the risk for disease incidence among enlisted personnel (8, 10, 23), and our findings indicate that the two groups differ significantly with respect to these characteristics. However, the rates reported in this study have been age-adjusted, thus controlling for this potential confounding factor. The number of hospitalizations in educational and occupational subcategories were too small to yield meaningful variable-specific rates. Nevertheless, while the occupational characteristics of the control group (which contains more apprentices and unrated personnel than the winter-over group) might explain their higher rates of disease incidence, the inverse relationship between education and disease incidence found in other studies (10, 23) would suggest higher rates among the winter-over group. This, however, was not the case. Further research is required to identify significant differences in potential confounding social and demographic characteristics between the two groups.

The physiological changes which occur during the Antarctic winter may account for the decreased risk for neoplasms and endocrine, nutritional, and metabolic disorders. However, caution must be exercised in attempting to posit a relationship between the winter-over experience and lowered risk for these diseases. The cases of first hospitalization among both groups are too few in number to warrant a definite assertion of the existence of an association, and the smaller rates among the winter-over group may be more indicative of their overall health status and the success of the screening program in selecting these individuals. Nevertheless, this association merits further investigation. One possible avenue of approach would be to examine the relationship between these diseases and variations in the immunocompetence of winter-over personnel. As noted above, in this relatively sterile environment, immunoglobins and leukocytes in healthy men at South Pole Station have been found to be significantly lower during the Antarctic winter than prior to winter-over duty (15, 16). This would suggest a reduction in immunocompetence upon return to the outside world. Outbreaks of common colds have been noted among personnel at many isolated antarctic stations immediately following the end of the isolation period and resumption of contact with the outside world (1, 15, 16, 22). An increased risk for infections and respiratory diseases might be related to the relative absence of viruses in the Antarctic and the lowered resistance associated with neutropenia (14). Reductions in immunocompetence also have been associated with the development and growth of neoplasms (3, 12). However, white blood cell counts return to normal levels shortly after returning to the larger society, and the incidence rates of diseases of the respiratory system and infective and parasitic diseases among the winter-over group were not significantly different from that of the control group, suggesting that immunocompetence is not adversely affected on a long-term basis. A study by Meschievitz and his associates (13) also failed

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4. TITLE (and Subtitle) HEALTH AND PERFORMANCE OF ANTARCTIC WINTER-OVER PERSONNEL: A FOLLOW-UP STUDY		5. TYPE OF REPORT & PERIOD COVERED Final
7. AUTHOR(s) Lawrence A. Palinkas, Ph.D.		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Health Research Center P.O. Box 85122 San Diego, CA 92138-9174		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Medical Research & Development Command Naval Medical Command, National Capitol Region Bethesda, MD 20814		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS MR000.01.01-6035
14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office) Commander, Naval Medical Command Department of the Navy Washington, DC 20372		12. REPORT DATE June 1985
		13. NUMBER OF PAGES
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)  Approved for public release; distribution unlimited		
18. SUPPLEMENTARY NOTES  To be submitted to <u>Aviation, Space, and Environmental Medicine</u>		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Antarctica > Performance; Morbidity; Hospitalizations; Operation Deep Freeze Health Risks. Enlisted Personnel		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Despite extensive previous research on the health and performance of Antarctic winter-over personnel while they are "on the ice," little is known about the long-term effects of the winter-over experience. Using the records of enlisted personnel who applied to the Operation Deep Freeze program between 1963 and 1973, the health and service history data available on these individuals at the Naval Health Research Center were examined to determine if incidence rates and performance criteria were significantly different between a group of winter-over personnel and a control group of enlisted personnel who were rated as acceptable by		



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a screening team but who did not winter over. Results indicated that the overall incidence rate for the winter-over group was significantly lower than the rate for the control group. The winter-over group also had significantly fewer first hospitalizations for neoplasms, endocrine, nutritional, and metabolic disorders, and diseases of the musculoskeletal system. No differences between the two groups were observed on any of the performance indices. Results suggest that wintering over does not adversely affect subsequent health and performance of enlisted personnel, and that the screening program has been successful in selecting the best candidates in terms of these criteria. *Keywords:*

S/N 0102-LF-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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